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Food for Thought: Exploring the Relationship between $PM_{2.5}$ Exposure, Dietary Patterns, and Changes in Brain Volume

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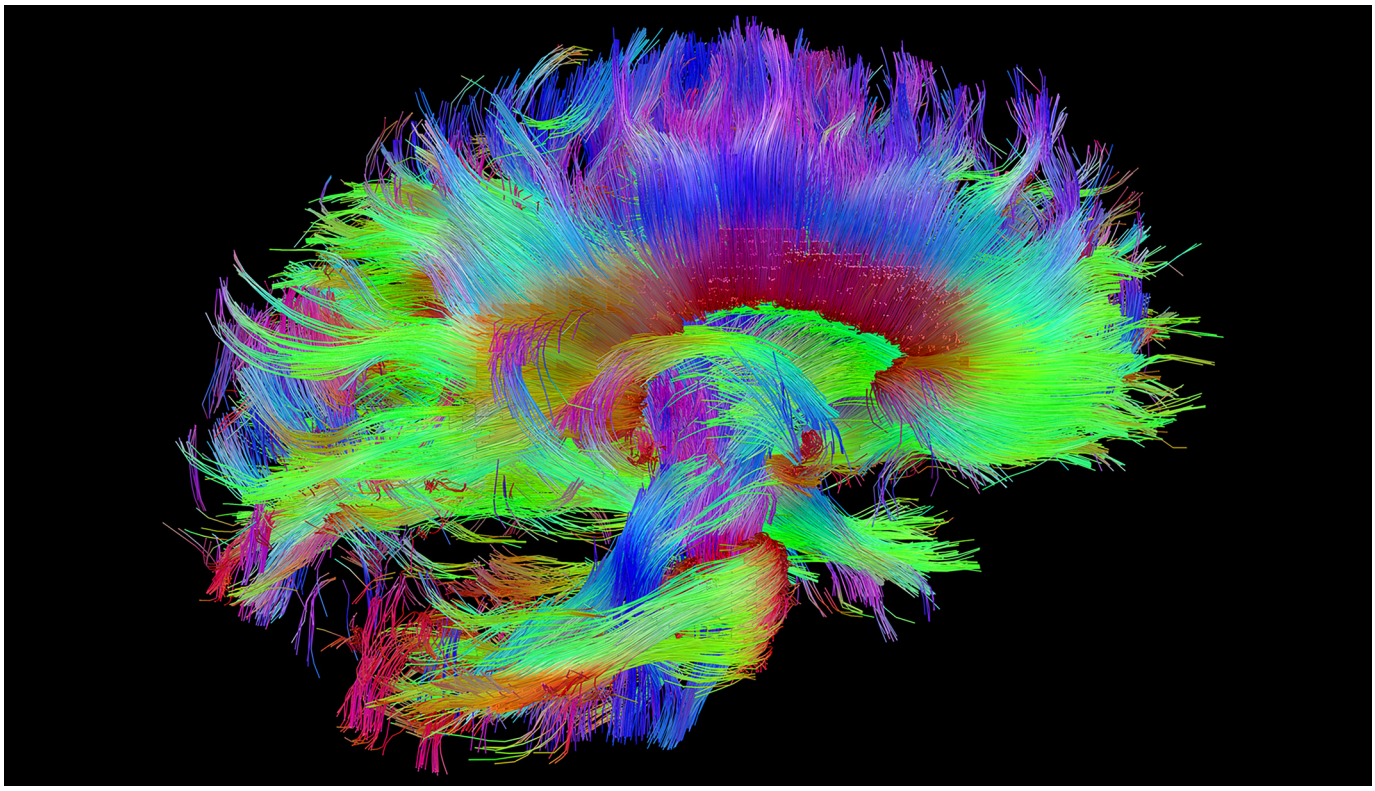
Exposure to fine particulate matter ($PM_{2.5}$) is associated with neurotoxic effects, including changes in brain volume and structure.[1,2] However, exposures are inevitable, so researchers are searching for potential interventions to protect the brain against pollution-related declines in memory and cognitive processing. A new study in *Environmental Health Perspectives* focused on the potential protective role that diet might play.[3]

The study was part of the Women's Health Initiative Memory Study–Magnetic Resonance Imaging, which is nested in the Women's Health Initiative Hormone Replacement Therapy (WHI-HRT) trial. Some of the authors had previously reported evidence that $PM_{2.5}$ exposure may contribute to loss of white matter volume (WMV) in older women.[2] For the present study, they assessed whether WMV in women 65–79 years of age differed between those who ate foods included in the so-called MIND diet and those who did not, in association with the women's estimated prior $PM_{2.5}$ exposure. The MIND diet—short for Mediterranean–Dietary Approaches to Stop Hypertension (DASH) Intervention for Neurodegenerative Delay—was developed as an intervention to slow cognitive decline.[4] Although evidence suggests the diet may decrease cognitive decline and incidence of Alzheimer's disease,[4,5] it is not exactly clear how it does so.[6]

Participants in the WHI-HRT trial completed a food frequency questionnaire upon enrollment in 1996–1998, from which a MIND score was calculated for this study. Each woman's MIND score was based on how frequently she consumed 10 "brain healthy" foods (leafy greens, other vegetables, beans, whole grains, berries, nuts, nonfried fish, nonfried poultry, olive and canola oils, and wine) and five "brain unhealthy" foods (butter or margarine, cheese, red meat, fried foods, pastries, and sweets). Magnetic resonance imaging (MRI) scans were completed in 2005–2006, and regional brain volumes were calculated for both gray and white matter. The investigators were especially interested in brain areas involved in memory, cognition, and Alzheimer's disease pathogenesis that earlier studies had associated with diet and $PM_{2.5}$ exposure. Participants' exposures to $PM_{2.5}$ were estimated based on their residential addresses from 1999 through 2006.

"Our study findings suggested that a dietary pattern characterized by higher intakes of vegetables and nonfried fish, and lower intakes of animal-based and high-saturated-fat foods, may help preserve WMV with aging and protect against the potential neurotoxic effects of $PM_{2.5}$ exposure," says senior author Jiu-Chiuan Chen, an associate professor of population and public health



White matter is composed of myelinated nerve fibers that connect various areas of gray matter to one another and to the spinal cord.[7] This diffusion spectrum image shows the fiber pathways of the human corpus callosum and brainstem. The fibers are color-coded by their orientation: red, left–right; green, anterior–posterior, blue, ascending–descending; other colors indicate where fibers overlap. Image: Courtesy of the Laboratory of Neuro Imaging and Martinos Center for Biomedical Imaging, Consortium of the Human Connectome Project, www.humanconnectomeproject.org.

sciences at the University of Southern California Keck School of Medicine. "This observation raises an important question concerning the possibility that $PM_{2.5}$-induced neurotoxicity on the brain aging processes may be reversed by nutritional intervention."

The researchers found that higher total and temporal lobe WMVs were associated with an increase in MIND score and that lower WMV was associated with greater estimated $PM_{2.5}$ exposures. Moreover, $PM_{2.5}$ exposure was associated with lower WMV only among women whose diet was less consistent with the MIND-like pattern at baseline.

"This paper provides an interesting template for more groups to examine two aspects of environmental exposures—in this case, diet and pollutants—simultaneously on brain structure," says Christy Tangney, a professor of clinical nutrition and preventive medicine at Rush University Medical Center, who was not involved in the research. "Probably the major limitation I see is the timing of these measures. What would have been more ideal is to use a food frequency questionnaire closer in time to the pollution measures, or average [the responses to] two questionnaires." Chen acknowledges that limitation but points to previous research[8] with longitudinal nutritional assessments, which suggests that dietary patterns tend not to change much in an individual's later years.

The authors pointed out other potential limitations. For example, the food frequency questionnaire completed by the women was not specifically geared to the MIND diet. In addition, the investigators had only a single imaging scan per person, which prevented the assessment of changes over time. Nevertheless, says Marc Weisskopf, director of the Harvard Chan–National Institute of Environmental Health Sciences Center for Environmental Health, "I found this to be a very well-done study. It is a great cohort with imaging and dietary data available, and large enough to do these kinds of analyses."

Weisskopf, who also was not involved in the study, adds that he would like to see a clearer assessment of possible confounding by healthy lifestyle characteristics that were not fully captured by the analysis. "There is more to do on this, but the findings point to the very intriguing possibility that aspects of diet can not only be neuro-healthy in and of themselves but could offer protection against adverse effects of toxicant exposures like air pollution," he says.

Wendee Nicole is an award-winning writer based in San Diego, California. Her work has also appeared in *Discover*, *Scientific American*, and other publications.

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